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Fiber Optic/Cone Penetrometer Systems for Subsurface Heavy Metals Detection

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Abstract

Science and Engineering Associates (SEA) developed a prototype subsurface soil characterization tool for the evaluation of heavy metals. The system, based on Laser-Induced Breakdown Spectroscopy (LIBS), is deployed using a cone penetrometer. The LIBS system consists of a laser source to produce the plasma, a novel hollow waveguide method of delivering the laser source to the subsurface, a small penetrometer probe for focusing the laser light to create a spark and return the light emission for analysis, a spectrometer to spectrally resolve the emission spectrum, an array detector for simultaneous measurements of emission intensities over a range of wavelengths and a computer to conduct equipment control, data acquisition, and data analysis. Under this two phase effort, the system was designed, fabricated and tested, culminating in a successful field demonstration at the DOE Sandia Chemical Waste Landfill for the evaluation of chromium contamination. During this CPT/LIBS test, six penetrations were conducted and the data obtained with the system was used to generate graphs depicting the concentration of chromium as a function of depth to approximately 15 feet, with a range of concentrations from background (? 30 ppm) to about 1200 ppm. In addition, prototype LIBS instruments, developed by DOE LANL personnel, were successfully field deployed by SEA at a Formerly Utilized Remedial Action Plan (FUSRAP) site for the detection of beryllium. This 6 week field effort generated a high density surface contour plot of the beryllium concentration over a 40 acre site. Utilizing both van-mounted and backpack systems, SEA evaluated 1664 samples at the site. This was the first full scale field deployment of the portable LIBS instruments and the beryllium concentration data was used successfully for real-time decision-making during the site characterization and for the development of additional plans for subsurface analysis.